

# *The NOvA Experiment*

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Mark Messier

Indiana University

*for the NOvA collaboration*

*181 scientists and engineers, 26 institutions*

<http://www-nova.fnal.gov>

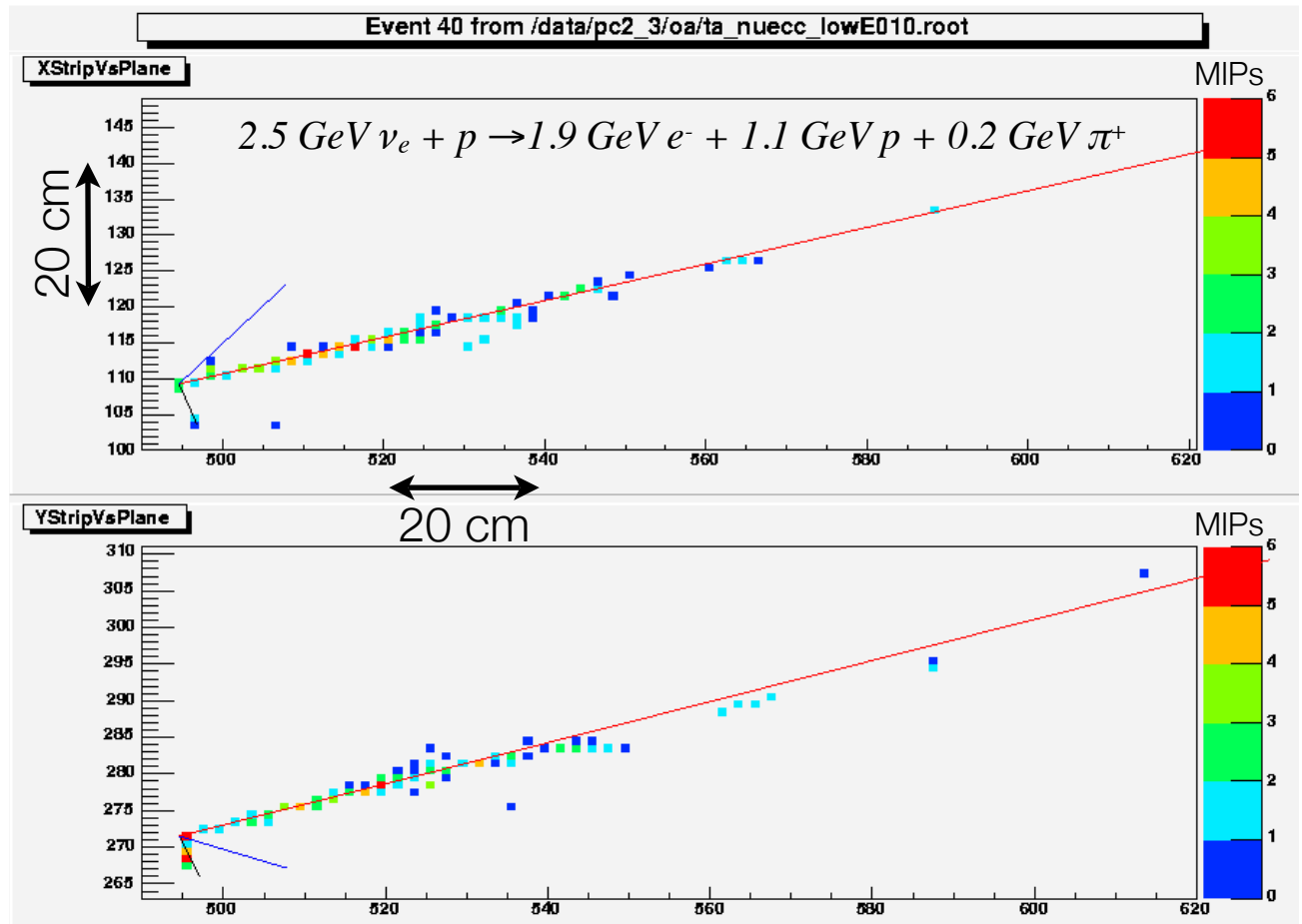
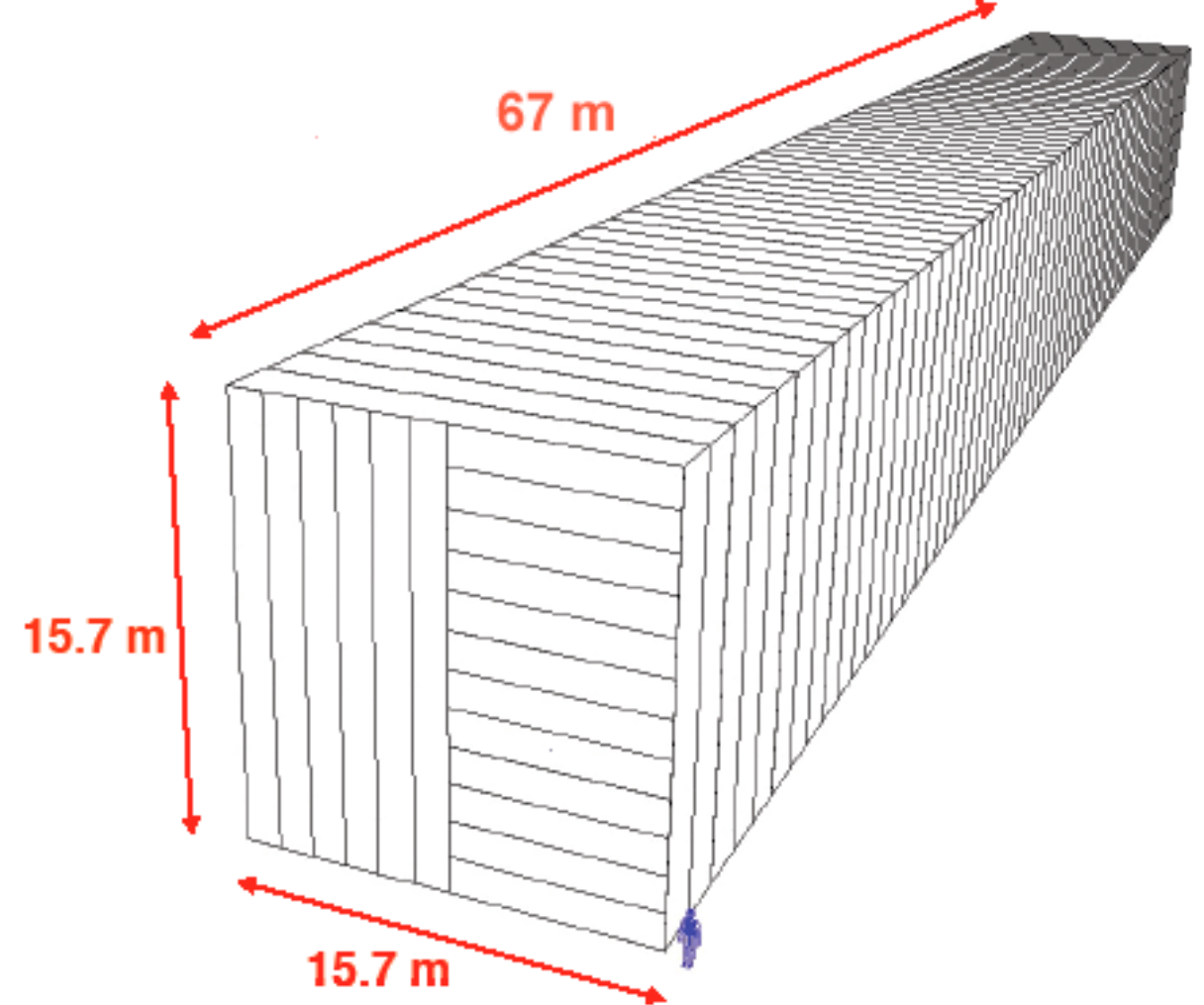
3rd Workshop on Physics with a high intensity proton source

June 5-6, 2008

Fermilab

# The NOvA Experiment

- NOvA is a second generation experiment on the NuMI beamline which is optimized for the detection of  $\nu_\mu \rightarrow \nu_e$  and  $\bar{\nu}_\mu \rightarrow \bar{\nu}_e$  oscillations
- NOvA is:
  - An upgrade of the NuMI beam intensity from 400 kW to 700 kW
  - A 15 kt “totally active” tracking liquid scintillator calorimeter sited 14 mrad off the NuMI beam axis at a distance of 810 km
  - A 215 ton near detector identical to the far detector sited 14 mrad off the NuMI beam axis at a distance of 1 km



## Questions for the future

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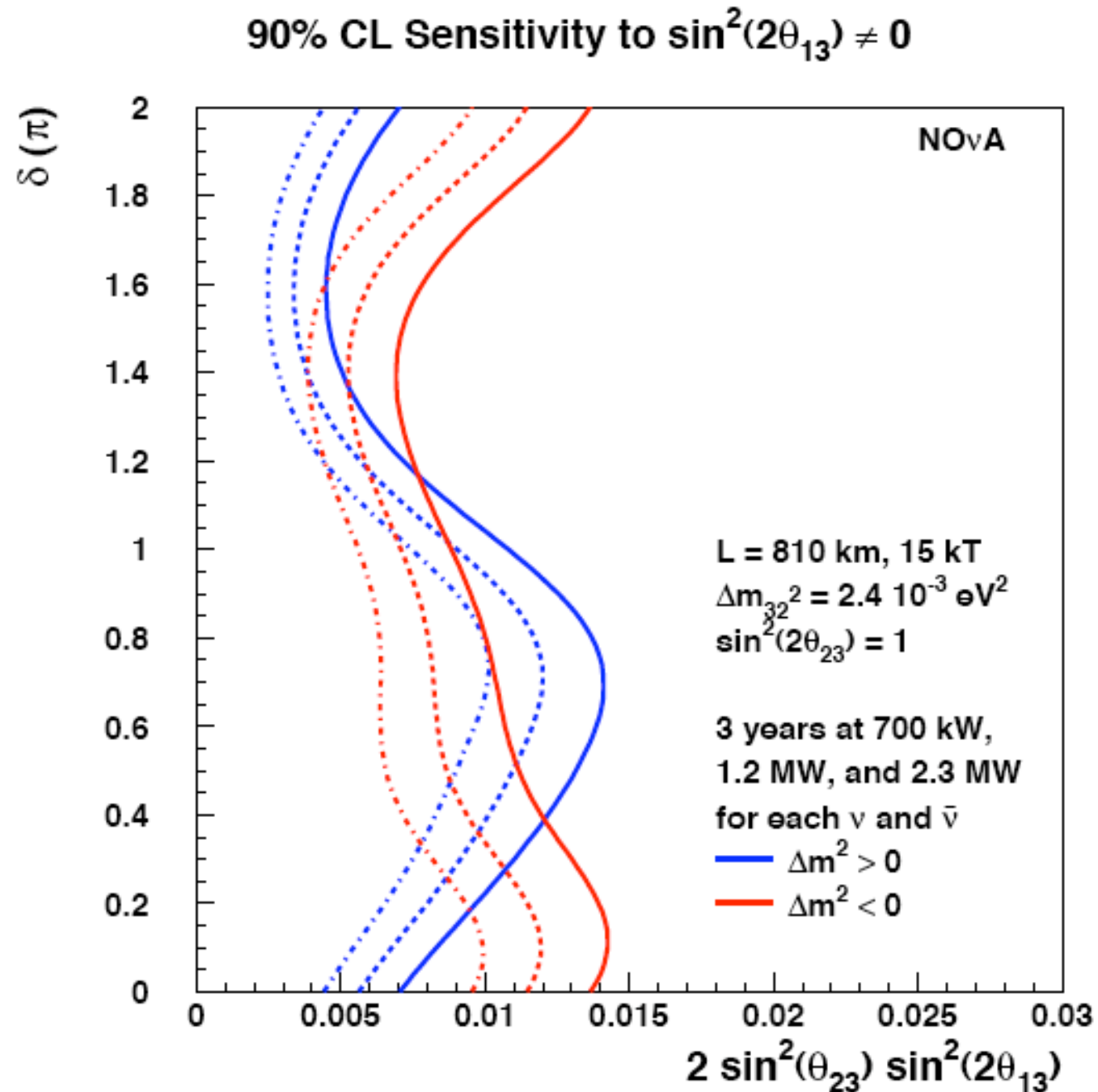
*excerpted from US Particle Physics: Scientific Opportunities. A Strategic Plan for the Next Ten Years. Report of the Particle Physics Project Prioritization Panel, May 2008*

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## 1) What is the value of $\theta_{13}$ ?



NOvA searches for electron neutrino appearance down to  $\sim 0.01$  at 90% CL



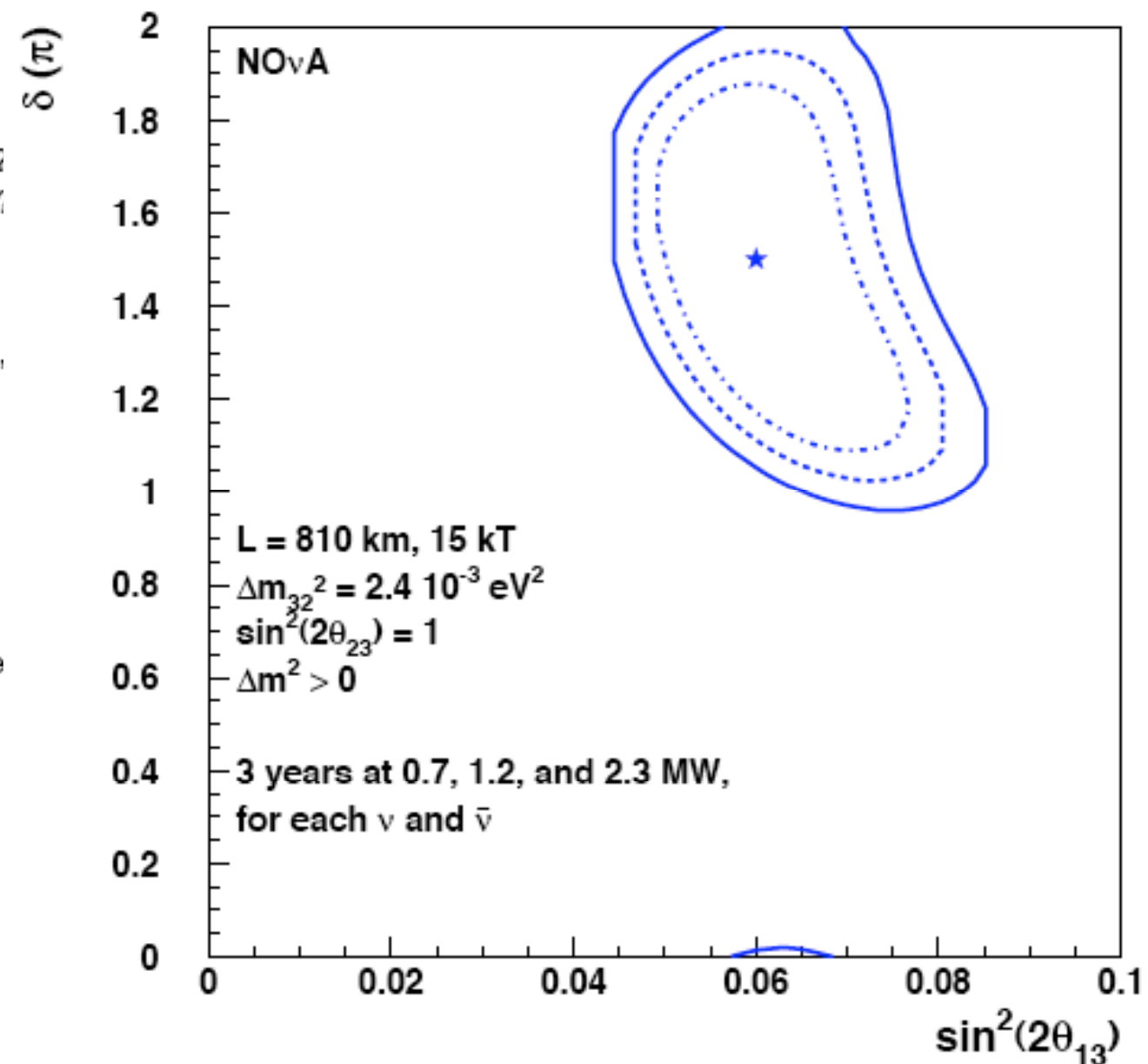
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## 2) Do neutrino oscillations violate CP?

1  $\sigma$  Contours for Starred Point



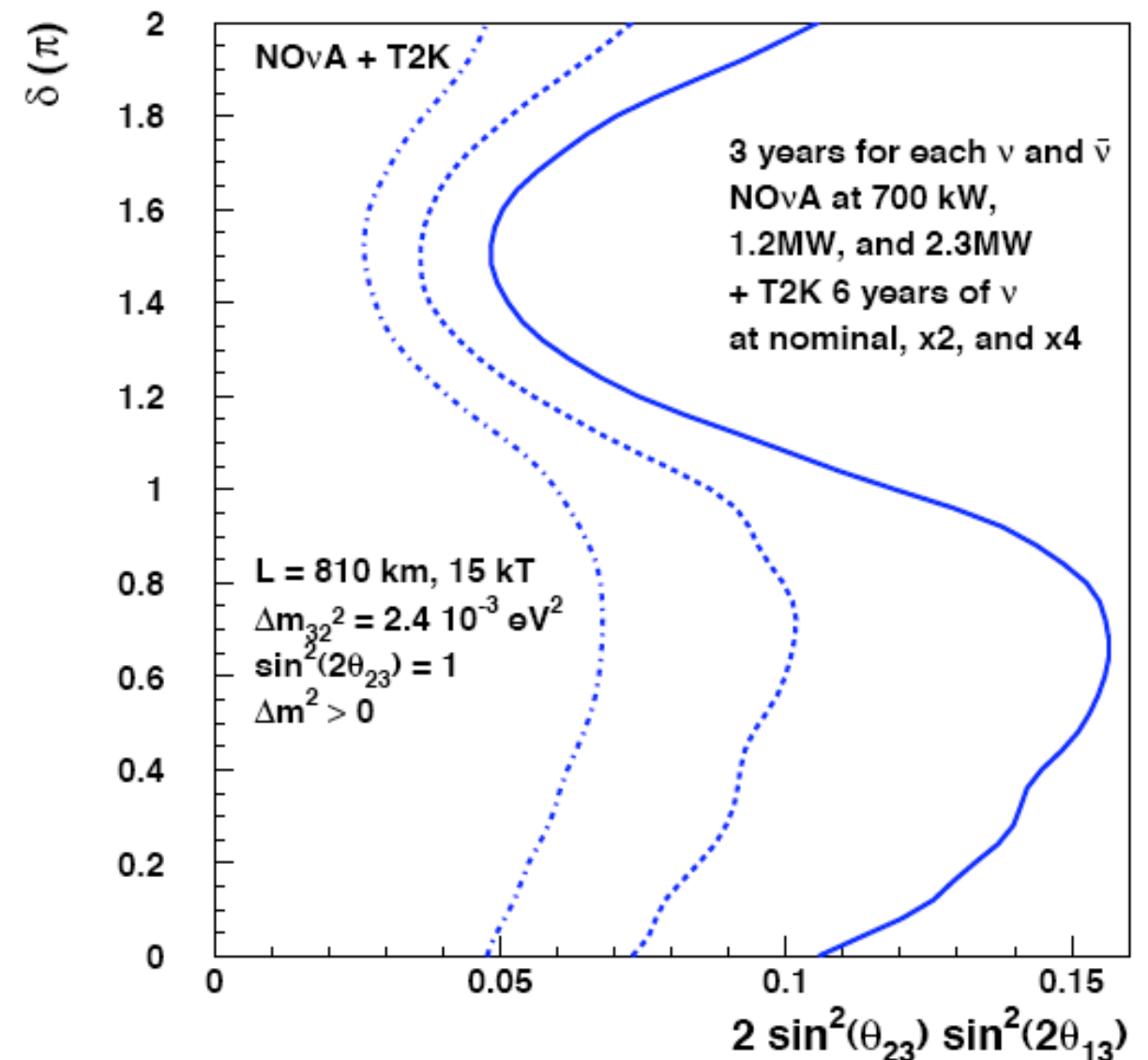
NOvA provides the first look into the CPV parameter space

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## 3) What are the relative masses of the three known neutrinos?



NOvA's long baseline makes it sensitive to the mass ordering



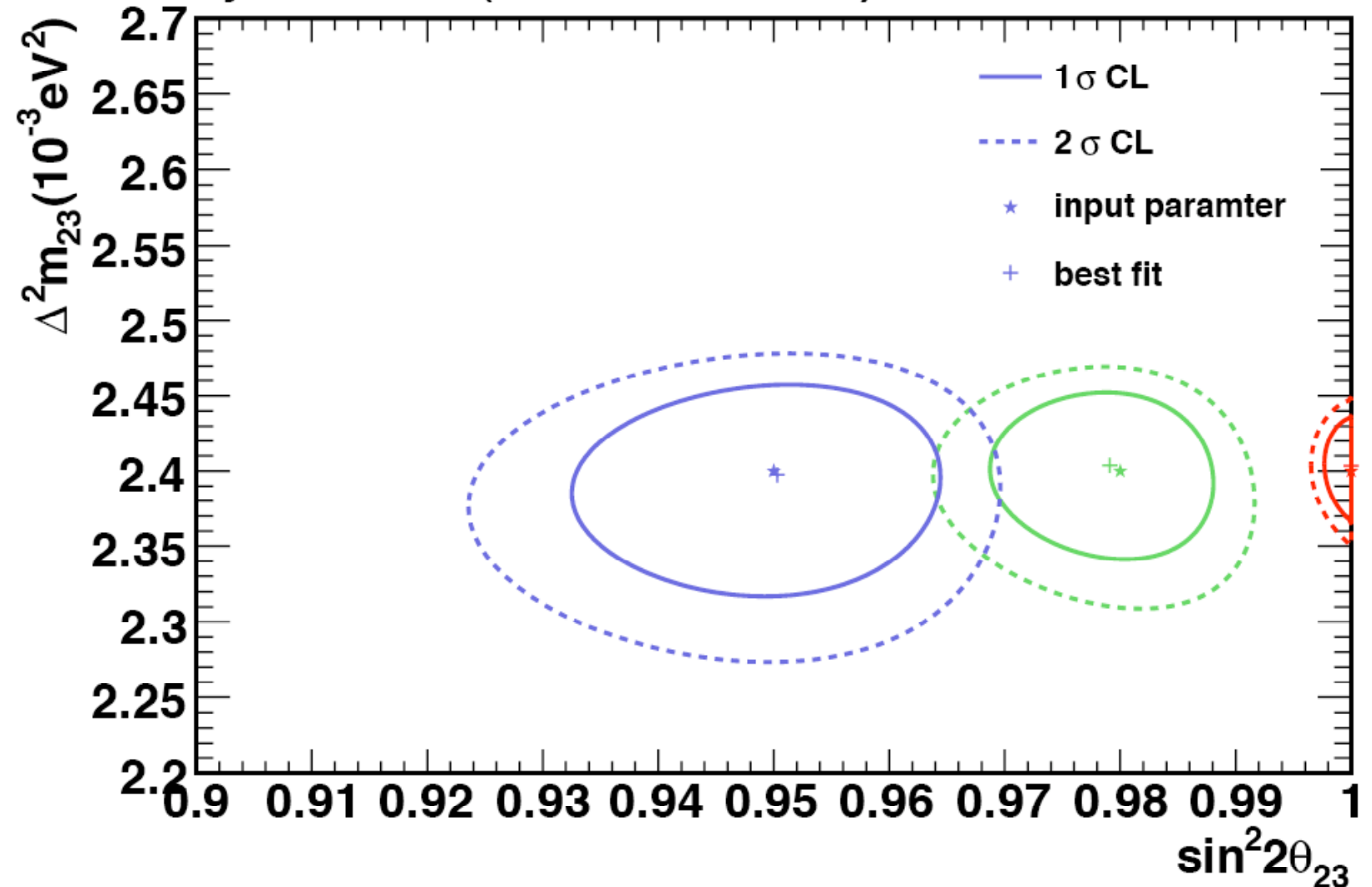
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- 2) Do neutrino oscillations violate CP? If so, how can neutrino matter-antimatter asymmetry among leptons in the early universe be explained? What is the value of the CP violating phase, which is related to CP violation among neutrinos related to CP violation among quarks?
- 3) What are the relative masses of the three known neutrinos: normal hierarchy ( $m_3 > m_2 > m_1$ ) or do they follow inverted hierarchy ( $m_2 > m_1 > m_3$ )? Oscillation studies currently allow determination of the ordering has important consequences for interpreting the results of double beta decay experiments and for understanding the absolute masses in a more fundamental way, restricting possible values.
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## 4) Is $\theta_{23}$ maximal?

Sensitivity Contours (15 kt\*36E20 POT)



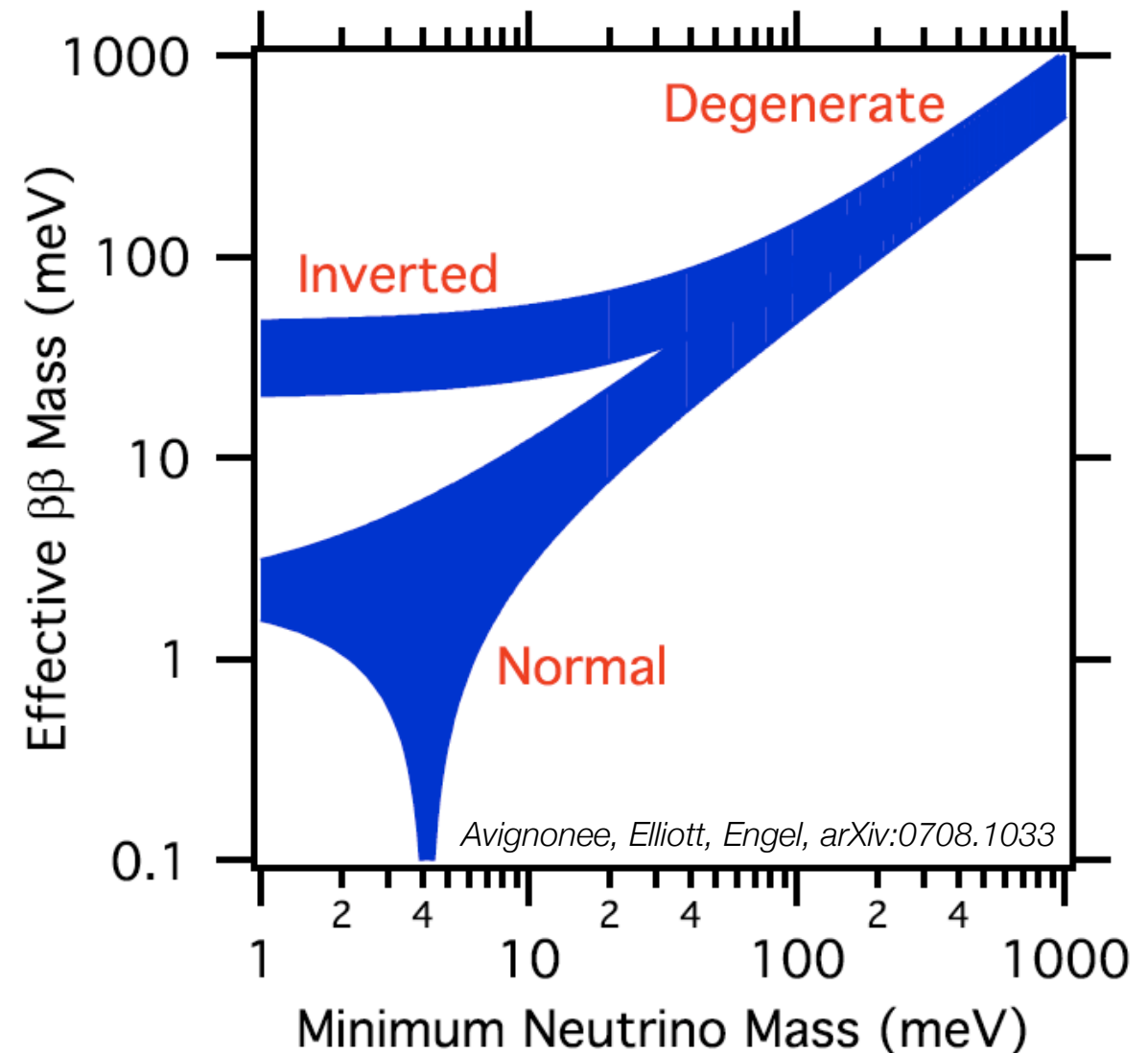
Because of its excellent energy resolution NOvA can make  $\sim 1\%$  measurements of muon neutrino disappearance using quasi-elastic channel

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## 5) Are neutrinos their own antiparticles?



If NOvA establishes inverted hierarchy and next generation of  $0\nu\beta\beta$  experiments see nothing, then it is very likely that neutrinos are Dirac particles

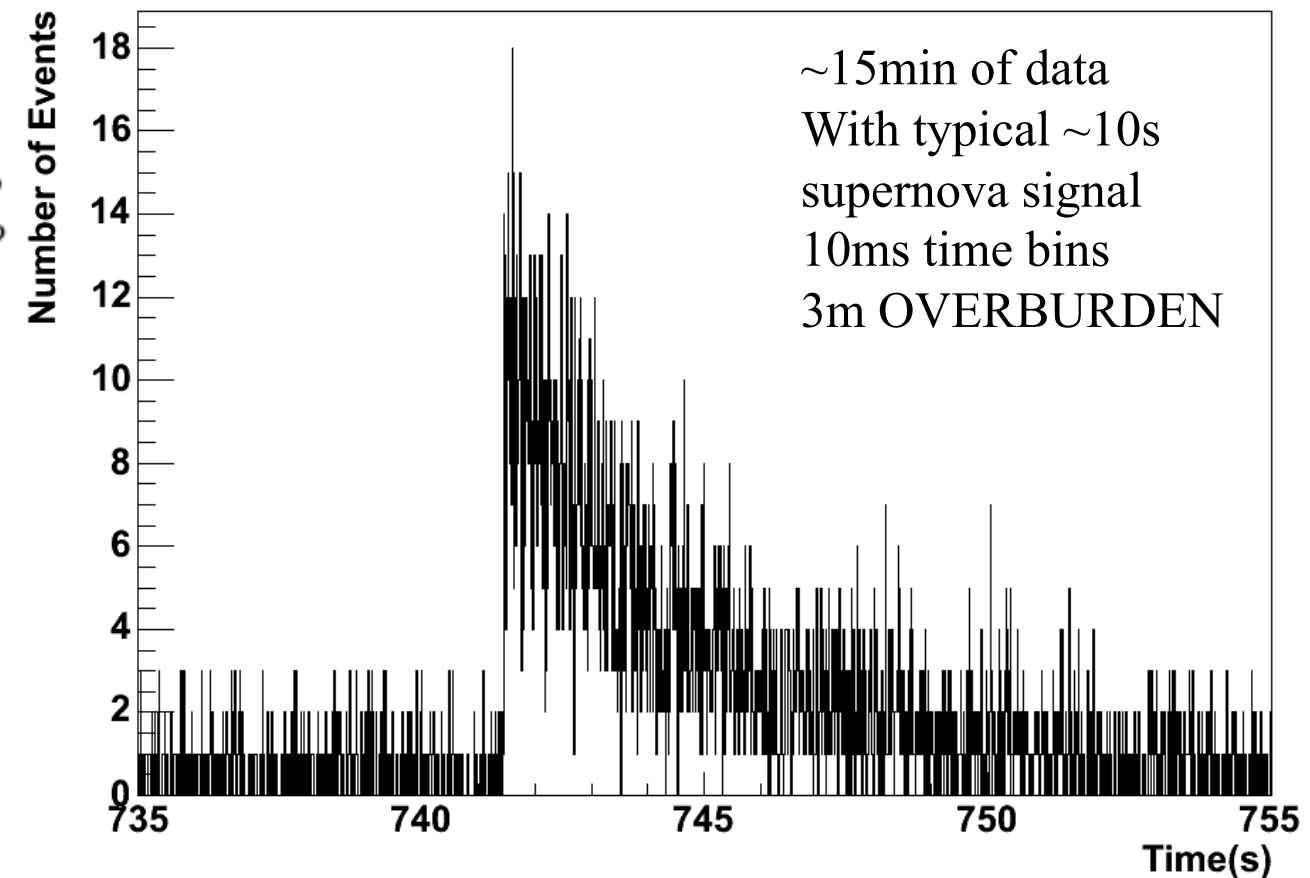


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## 6) ...supernova within our galaxy?



NOvA would see burst of 5000  
events for a supernova at the center  
of the galaxy

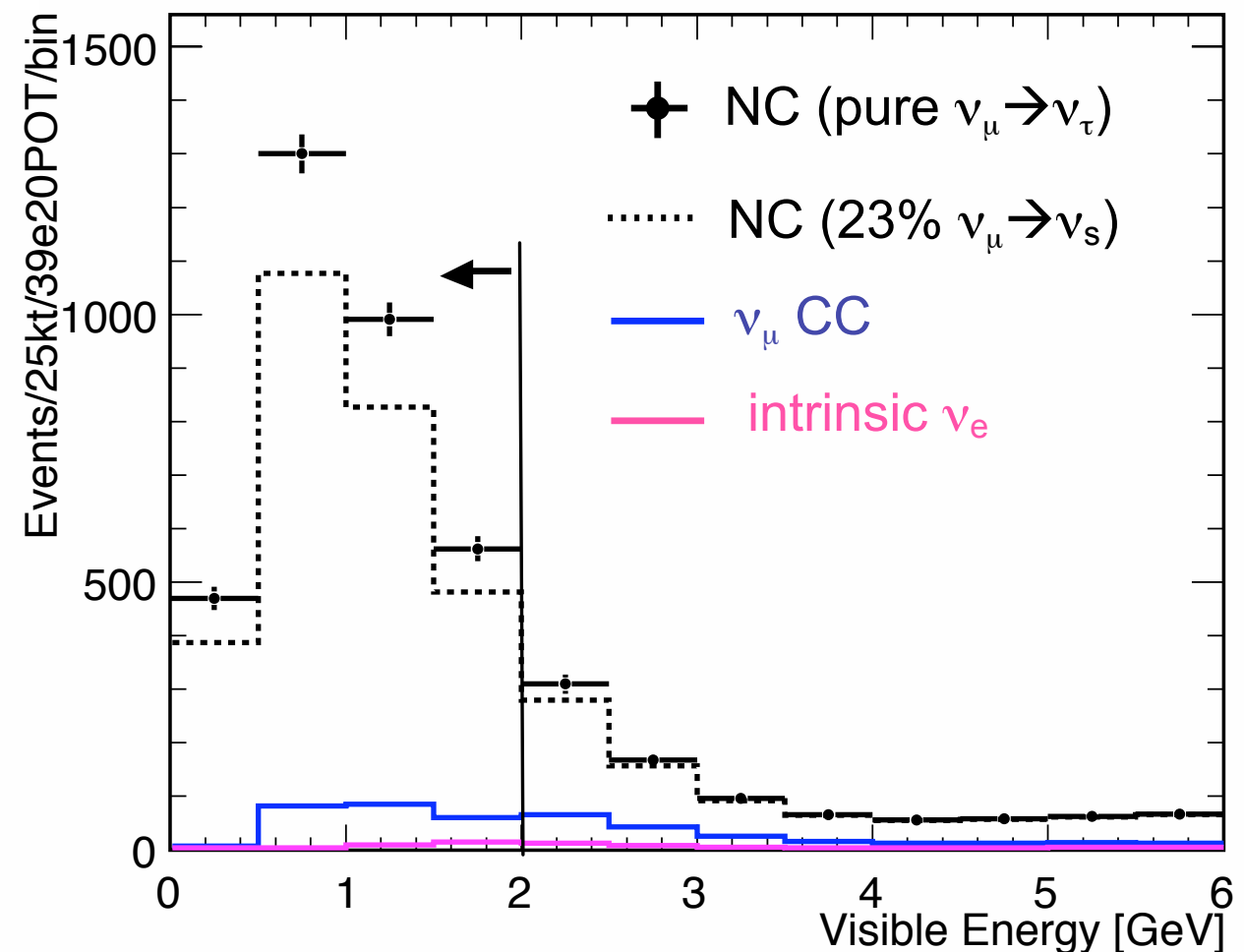
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## 8) ...beyond the Standard Model...Do sterile neutrinos exist?

### Reconstructed visible energy for NC sample



NOvA's granularity allows for clean  
neutral-current measurements  
facilitating searches for sterile neutrinos

# Schedule

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- Despite FY08 omnibus work continues
  - NOvA passed DOE Office of Science CD2/3a in Oct. 2007.
  - Passed External Independent Review (EIR) in Nov. 2007
  - FY08 Omnibus required repeats. Passed DOE Office of Science CD2 review again in April 2008. EIR scheduled for June 19.
  - Expect CD3a in Feb. 2009, CD3b in Sept. 2009
  - Were it not for the omnibus, construction would have started 3 months ago
- Cost & schedule adjusted to include FY08 omnibus and anticipated 4 month continuing resolution in FY09
  - Start of construction April 2009
  - First 2.5 kt taking data August 2012
  - Detector complete January 2014
- NOvA construction schedule is driven by funding profile. We know what we want to build and we could build it faster.



# NOvA and the P5 roadmap

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NOvA is the foundation of the US accelerator neutrino program

- It addresses 7 of the 8 physics questions called out by P5 as the focus of the neutrino program over the next decade
- Among the next generation experiments, NOvA uniquely provides information on the mass hierarchy and CP phase
- NOvA provides the incentive and continuity to increase the NuMI beam power from 400 to 700 kW and ultimately to 2.3 MW
- Ensures a robust future program.

